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A Functional Mathematics for the Engineer:An Approximation to theTrigonometrical Series of Fourier

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Abstract

The research reported here is the social construction of the mathematical knowledge in engineering field in higher education. It takes that knowledge is built according to the rules and practices are established explicitly and implicitly by the social community in which knowledge is situated, be it in this case engineering in schools. It proposes an approach to the Trigonometric Series Fourier (STF), promoting a functional mathematics. Thus the research shows how mathematical knowledge of known knowledge, is disrupted, changed and amended to take into the classroom, when they take the impact of institutional, socio-cultural environment of the engineering community in training and learning functionality of knowledge within the activities of the engineering community teachers. It´s considered that mathematical knowledge will provide a sense and meaning to the student if it is built within a community and gradually incorporate it relates to their activities and social practices of their cultural environment thus encouraging the learning of mathematics articulated integrated and functional.

Keywords: Functional mathematics; Social practices; The social construction of the mathematical knowledge

1. Introduction

The knowledge of mathematics in higher education plays a special role in the case of engineering for example, must be a tool for learning the discipline itself and related sciences and also finques knowledge, skills and skills in an integrated manner throughout the race will shape the discharge profile of the student as a professional engineer.

The research reported here is the construction of mathematical knowledge in the field of engineering within the top level. One of the problems in the academic training of an engineer is the location of isolated skills. Knowledge that the student does not make sense or meaning. And with consequences that are reflected in the difficulty in learning both notions of the same discipline as the disciplines of socio cultural. And difficulties in their integration into professional life may correspond to the skills and competencies that are not developed or not developed properly during their academic life in school (Muro, 2004).

In the work reported is argued that learning is a human activity, situated and ruled by social contexts and practices that are shaped and transformed the reality of the learner depending on location, the space and time .The research gives an account of how mathematical knowledge of known knowledge, is disrupted, changed and amended to take into the classroom, when they take the impact of institutional, socio-cultural environment of the community of engineers in training (engineering student) and functionality of knowledge within the activities of the engineering community teachers. It gives evidence that the institution and the social environment, they give the normativity for the objectives and forms of knowledge and consequently becomes a scientific knowledge to an ability to teach, to knowledge that is functional and that tribute to shape the profile of a engineer within their area.

This requires that the courses promote knowledge of mathematics as to support strong and effective training of future engineers. That promote mathematical thinking is developed and evolved through their academic, analytical thinking, reflective, and deductive logic of engineering and likewise we provide appropriate and relevant tools, which together may be functional for development and professional life.

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Consequently school mathematics should not be limited to the part of the curriculum that is consigned to the issues, objectives and programs of study, but must promote the thought processes that each topic is operated as in the case of the demonstration, under hypotheses or reasoning and approach the resolution of problems (R. Cantoral, R. Farfán, F. Cordero, Alanis J., R. Rodriguez, A. Garza, 2005). And the pair must be a mathematical functional in the sense established by Cordero (Cordero F., R. Flores, 2007):

"... an organically knowledge embodied in humans that transforms it and to transform their reality ..." .

This is presented in a way that can contribute to building a functional knowledge. The study proposing an approach to the Trigonometric Series Fourier (STF), where treatment of the mathematical object promotes the ability to "mathematical visualization." Considering this ability as part of an "advanced mathematical thinking" that is convenient to the area of engineering involved. The issue is part of the subject: Transform Functions of the third semester of Engineering in communications and electronics (ECE) offered at the Instituto Politécnico Nacional (IPN), Mexico.

2. The impact of the social and cultural context

On the social dimension led to consider various parameters such as the objectives of the institution, career goals, curriculum, socio-cultural environment of the student (call engineering community in training) and the engineering community teachers (Teachers who are engineers first and then the relevant area or two are teachers in the area of applied engineering and engineering sciences).

The analysis of the plans mentioned are conducted through documentary analysis, design and implementation and analysis of interviews with mathematics teachers who give the subject, teachers engineers who use the course.

2.1 The Institution

The Instituto Politécnico Nacional (IPN), is an educational institution which affects three major areas of knowledge: Medico-Biological Sciences, Social and Administrative Sciences and Engineering and Physical Sciences and Mathematics. It is responsible for the training of professionals to meet the demands and issues raised by society. These professionals are trained since the high school level, higher and postgraduate levels.
In brief IPN's mission (IPN http://www.ipn.mx):

MISSION OF INSTITUTO POLITÉCNICO NACIONAL

*The**Instituto Politécnico Nacional** the school is secular, free of State, president of Public Technology Education in Mexico, a leader in the generation, application, dissemination and transfer of scientific and technological knowledge, created to contribute to the economic, social and political development of the nation.*

To achieve this, the community is fully professional in higher average levels, higher and postgraduate courses, conducts research and society extends their results with quality, accountability, ethics, tolerance and social commitment.

Each and every one of the centers and schools that make up the IPN, work systemically as a whole to carry out this mission.In particular the Escuela Superior de Ingeniería Mecánica y Eléctrica (ESIME). It has four campuses: Campus Zacatenco, Ticoman, Aztcapotzalco and Culhuacán Campus. Campus and Campus Zacatenco Culhuacán Race is offered in Communications and Electronics Engineering.

To carry out its mission the IPN as its graduates under the framework of an educational model (ME). This model focuses on learning. The student must construct their own knowledge. The MOU is based on social constructivism and promotes meaningful learning, comprehensive and life, being the learner builder, creator, producer of their own learning, self-regulated responsibly. Thus changing the role of teacher to be the intermediary bridge between knowledge and the student. Can be considered as the core philosophy of ME is "the student learns to grasp", in this way prepares you to adapt and live in the contemporary world of relevant and appropriate way because their preparation is integral to consider the issues: namely (discipline or knowledge), know to be (as prepared as someone immersed in the society), know-how (what to be prepared as a service to society) and knowledge sharing.

2.2 The engineering in the ESIME

The ESIME Culhuacán, offer the following engineering: Automotive systems engineering (ISISA), Mechanical engineering (IM), Computer systems engineering (ISC) and Communications and electronics engineering (ICE). Some of the subjects are part of a common trunk.

Our research is situated in the career of ICE: the aim of the engineering in communications and electronics

CAREER OBJECTIVE

To form professionals with high sense of ethics and commitment to their community in the technological field of electronics and communications, capable of addressing and making decisions with creativity, order and method in relation to technological problems, able to design, construct and evaluate from different points of view and with scientific and technological fundamentals, devices or systems that solve problems in the area. With appropriate training to communicate their ideas through language and integrate projects that include impact and sustainability. Consider the importance of teamwork, promoting cooperation, tolerance, solidarity and responsibility, and also to analyze and assess the impact of technological development causes in the world of work, the socio-economic and environmental. (ESIME-IPN, 2008)

You can see that engineering education must be comprehensive; in this formation the different areas of the subjects have a particular role at the end of the race results in a graduate with the following profile:

Profile of the gone away engineer

The graduate of the ESIME Culhuacán, through the educational process, obtain professional training critical to the reality that will allow you to employ highly qualified resources, using the latest technology to stay ahead and take control of total quality industrial processes, together with the sense of social responsibility of processing, preserving the environment, and perform their profession in public sector enterprises or private. (ESIME-IPN, ESIME Culhuacán, 2008)

The skills, capacities and the aptitude of logical abstraction to solve problems that they characterize the profile of the professional of the engineering, It is in preparation from the beginning of the studies of the top level, is conforming and evolving as the student advances in his academic life, there being done inherent part of his personality. This can be seen as a pyramid (Figure 1), where the base of this formation (the base of the pyramid) is the basic sciences

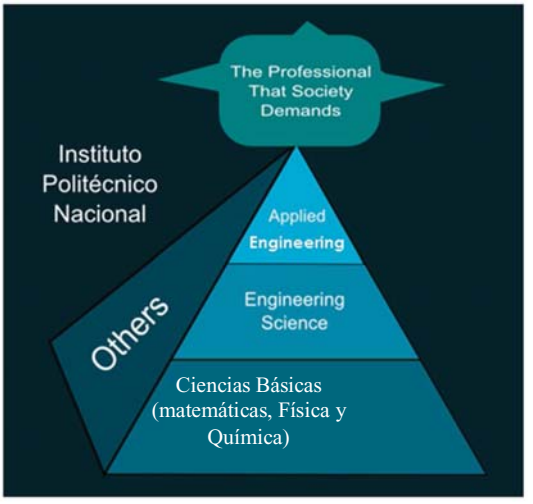


Figure1: The training profile of a future engineer.

The allocation of hours recommended by the CASEI (Consejo de Acreditación de la Enseñanza en la Ingeniería) in general for any engineering is:

- Basic Sciences and Mathematics: 800 hours
- Engineering Sciences: 900 hours.
- Applied Engineering: 400 hours.
- Social Sciences and Humanities: 300 hours
- Othercourses: 200 hrs.

The base of the pyramid and the recommended number of hours reveal that when the mathematical knowledge of students refer to our socio-cultural context given by the institution's objectives underlying the learning of mathematics can be stated as recommended by the National Council of Teachers of Mathematics (NTCM, for its acronym in English):

- ***The aim in teaching mathematics is to help all students develop mathematical ability.***
- ***Math is not a set of isolated topics, but rather an integrated whole***

With what we see the need for mathematical knowledge engineers in training should be a functional knowledge.

2.3 Plans and Programs of Study

The curriculum structure interrelates each of the subjects, the analysis made to the curriculum for content, Figure 2 shows how they relate to the relevant subjects of mathematics. A total of seven are taught mathematics, and such prior knowledge of mathematics that the student has before the subject of Fourier, and others are linear transformations, linear combinations, base and dimension, vector space, linear dependence and independence, infinite series. It is assumed that the Fourier trigonometric series should be posed as an infinite linear combination of orthogonal functions, where the trigonometric functions are a special case of Generalized Fourier Series.
We consider the desirability of this, because, for example, in the fifth semester in the subject of Communications I, it is necessary to construct the Fourier series with complex exponential functions, or in some cases with the Legendre polynomials or as the set of Laguerre basis functions.

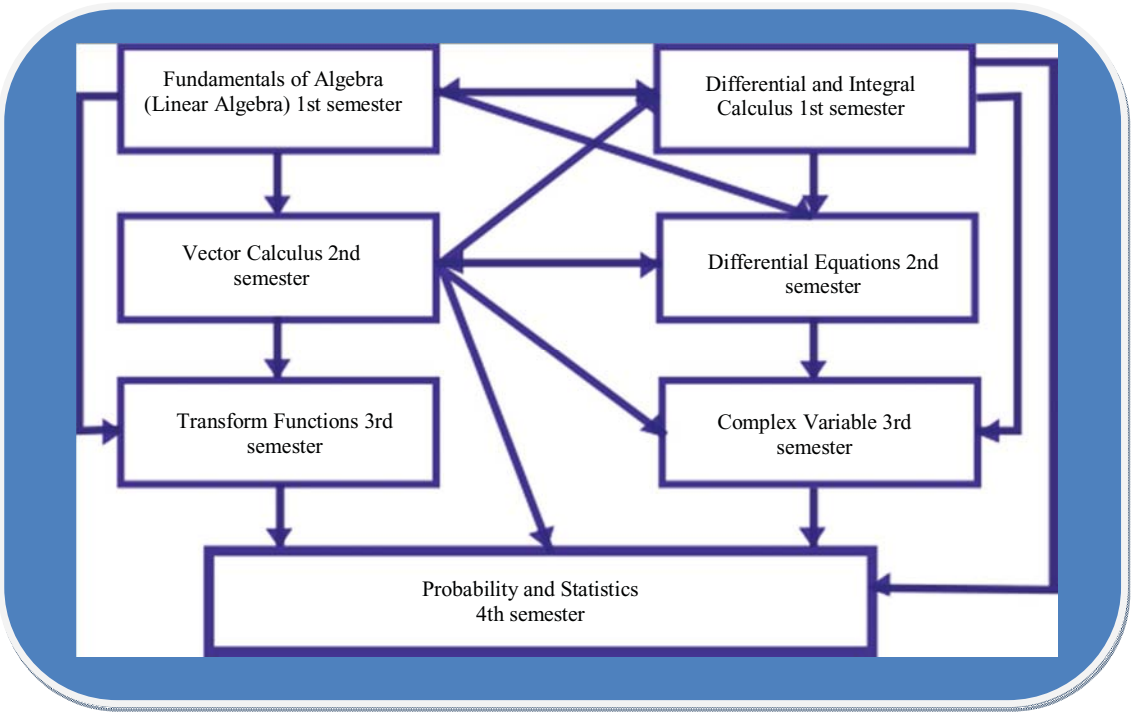


Figure 2: Shows the interrelationship of mathematics courses.

On the other hand, of the own subjects of the engineering, there is language that would allow that the student should assign senses and meanings to him to certain concepts since it are the linearity, the homogeneity. It may represent some operations with block diagrams. For example the addition of signals and scalar multiplication can be represented as in Figure 3:

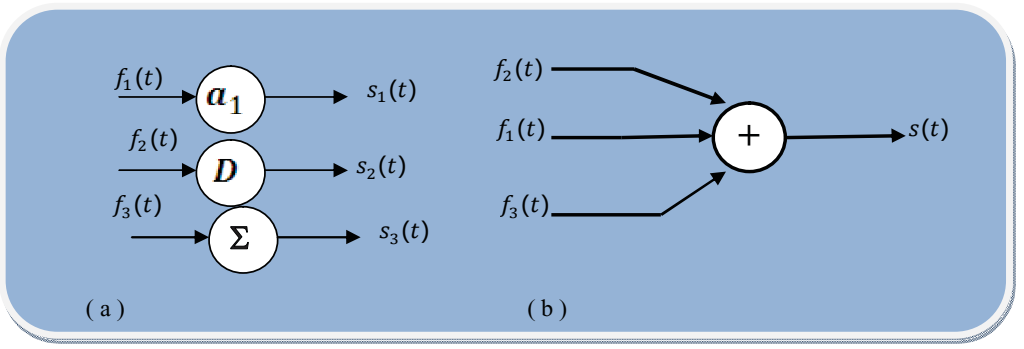


Figure 3: In (a) presents a multiplier, a derivator and one resumptive. In (b) are the sum of some signals.

A continuous-time signal is one that is defined at all times on some interval of time. Another name given to the continuous-time signal is the analog signal. This name comes from the fact that in many systems, the analog signal variation with time is analogous to a physical phenomenon that is being measured or monitored.

A sign of continuing value is one that can have a value that is within a continuum of allowed values. The continuum can have a finite or infinite extent. A continuum is a set of values without "space" between the allowed values.

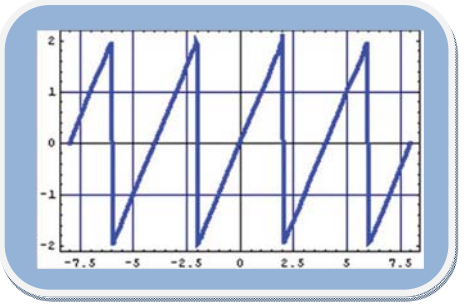


Figure 4: The mathematical function is "tooth saw", with discontinuities.

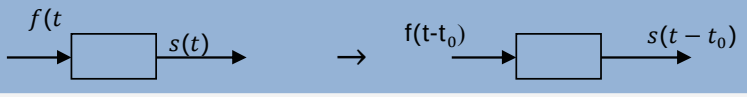
However in the physical context, it is considered a signal value continum. (on the timeline the projection of the graph would be a continuous straight). The signal can represent the loading and discharging of a capacitor.

The analysis of signals by the STF can be done with linear systems time-invariant (LIT). This is because the properties of linearity and invariance in time.

A system is time invariant if their behavior is independent of time is if the system has a "gateway" which will cause an "out" and is not dependent on the instant when the system is analyzed. For example loading and unloading of a capacitor is time invariant, since under the same conditions the phenomenon depends on the moment that is loaded or unloaded.

In the field of engineering is defined as:

If an arbitrary "entry" f(t) of a system causes a response s(t), and an entry f(t-t_0) of system causes a responses$(t - t_0)$ at any arbitrary time t_0 is said that the system is invariant over time



With this managing to blocks, the mathematical language and the language of the engineers it is possible to understand better a system that is linear if it meets two conditions: be uniform and be additive (Figure 6).

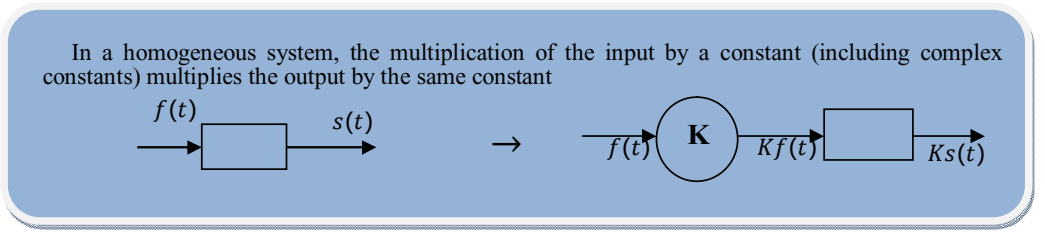


Figure 6: Diagram of a system to blocks homogeneous.

Or as shown in the following Figure (7), associated to add signals which can be harmonic

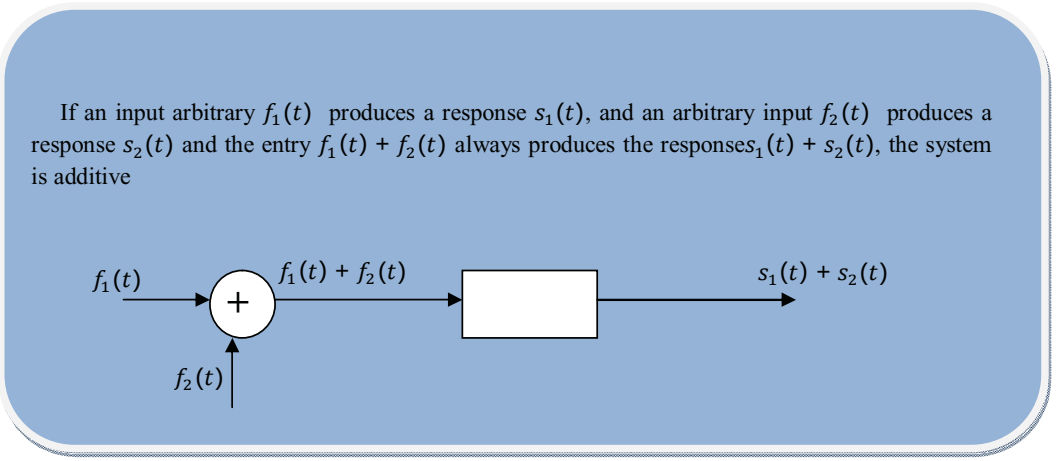


Figure 7: Diagram to an additive system blocks.

Mathematically a system is linear if it is both homogeneous and additive. This feature of the linear system is called superposition. This section has presented some concepts and terms that are part of the domain of the engineering community. The concepts involved non-mathematical objects are introduced in different subjects such as physics, circuit theory, transient analysis, Theory of Communications, So that for a student of third semester most of them are familiar.

3. General Reviews

Research has considered the school system's component parts (i.e. teacher, student, classroom, institution and social interactions) in the role they represent in the construction of mathematical knowledge (Lamb, 1998). Consequently, the systemic approach to the problem studied since, at the same time take into account the student's knowledge, the epistemological dimension of knowledge, social practices involved also takes into account the work of the engineering community teachers (teachers applied engineering or engineering sciences are trained engineers who maintain contact with engineering or engineering research, and that somehow impact the mathematical knowledge required in the school building.

From the point of view socioepistemologic approach, legislation that has been said requires the notion of institution. Well, unlike the psychological approaches that explain the process of understanding from a mental standpoint, the work has a systemic frame understanding that the learner does in an institution ruled by practice. Thesis has already been studied and developed within the Mexican community of mathematics education, for example in the report Arrieta doctoral thesis (Arrieta, 2003), doctoral thesis Montiel (Montiel, 2005), work Master reported by Covián (Covián, 2005).

So with this in mind, in the case of engineers in training of ICE, one of the bases in the construction of engineering practice is the analysis of signals, since they, among other things: analyze signals when designing a circuit, a control system, implement an acoustic design, build an antenna or electromagnetic radiation of certain features. As one of the elements that are considered of utmost importance, not only at the level of the subjects of mathematics, but as a competition that promotes and develops along the student's academic background is "the mapping function (AGF).

Another element as the AGF is to study the notion of Trigonometric Series Fourier (STF) as a basis to build a "Generalized Fourier Series", since as is known in the field of engineering (Oppenheim, 1998) (Roberts, 2005), the future engineer needs the STF, the number of complex Fourier series and orthogonal functions which are (among others) the polynomials of Laguerre and Legendre. As these two elements which constitute a basis for harmonic analysis(Guzmán, 1983), a key part of the signal analysis, since any phenomenon that requires study the engineer is modeled by signals (functions) of voltage or current (mainly) .

In another aspect, the thematic content analysis of the subject program Transform Functions (TF) and text analysis, is the importance of mathematics to integrate knowledge with other areas and disciplines of the school context, so it is assumed that the engineer in training should be incorporated gradually to its academic and professional community. So as an engineer working with some special functions (functions that unfortunately are not explicitly in the curricula of mathematics and that, therefore, is at the discretion of the teacher the study) should be incorporated for consideration as a basis for analysis signal. Similarly it is considered necessary to incorporate the terms of the engineer's own language such as: signal linear time-invariant, homogeneous and additive signals, see the signals as power, current and voltage waveforms with different e.g., pulse train, unit impulse, sawtooth.

4. Final Comments

The investigation began with the search for elements needed to promote mathematical knowledge that is functional for the engineer; Especially one presents the form in which the series of Fourier lives in engineering Communications and Electronics.The systemic approach to the studied problems therefore alongside that knowledge of the student, the epistemological dimension of knowledge, social practices involved are taken into account also takes into account the work of teaching engineers (teacher of applied engineering.) or have training engineers and maintaining contact with engineering or engineering, research because it somehow impact mathematical knowledge required build in school engineering sciences community.

Thus an engineer forms from within institutional on functional knowledge that will inherently incorporating the person of the student and that are normados in principle by the institution, whereas as a notion of the school context, plans and programmers of study, the interrelationship and situation that exists of subjects within the curriculum, map to the textbooks, the community of academics, engineers student with their cognitive background and experience. On the other hand, repelled by the culture of a place in certain time and space, partner environment institution's career is academically seeking to respond to a social need, in this case, the competent in the area of communications and electronic one of the sectors of greatest growth in the last 10 years in Mexico engineers need and that this trend will continue upward as well according to forecasts requiring prospects for growth of the country (engineering, 2005)

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